WIDE-SCREEN SCANNING SYSTEM FOR FILM-TO-TAPE TRANSFER

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ABSTRACT

A high percentage of feature motion picture films intended for theatrical release are produced in a format intended for a wide-screen presentation. For television transmission, a special print normally is provided wherein the film frame is masked to the narrower format. The masking is moved horizontally to follow picture information essential to the story.

The system described herein accomplishes the scanning operation during real-time transfer of film to tape. An optical system, controlled automatically from recorded cues, moves the wide-screen image to specific horizontal positions relative to the camera aperture at the appropriate film frame.

By the elimination of the film processing laboratory scanning operation and production of special prints, substantial cost savings are achieved in the transfer of a feature film program to the television format.

The two most commonly used projection aspect ratios of wide-screen motion-picture films produced for theatrical release and presentation are 1.85 and 2.35. In the 1.85 format the increased width, relative to height, is achieved by the simple expedient of reducing the frame height and increasing the magnification of the projection lens. The relationship between the 1.38 and 1.85 film frames is shown in Fig. 1.

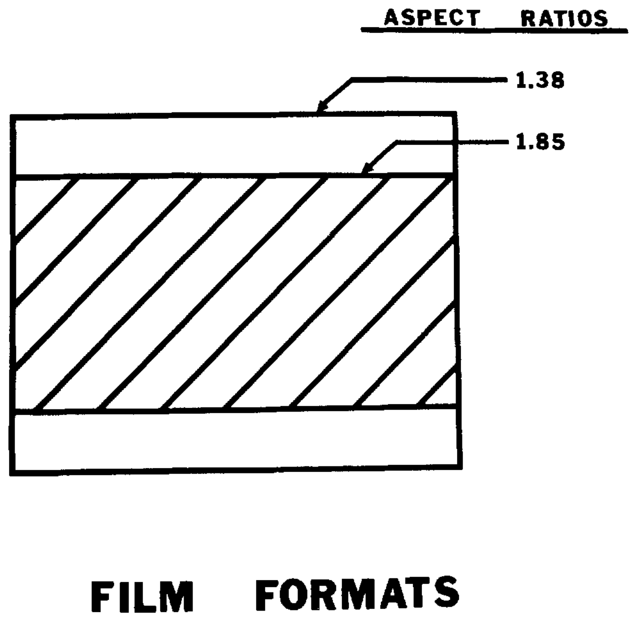

Fig. 1. The full image area of the film frame is used in projection of a 1.38 aspect-ratio format and in anamorphic projection of a wide-screen 2.35 aspect-ratio format. Non-anamorphic wide-screen projection in a 1.85 aspect-ratio is achieved by a reduction in the height of the image area.

In the wider 2.35 aspect-ratio used for Cinemascope, slightly more than the conventional film frame height is used and the increase in scene width relative to height is obtained by squeezing the image horizontally with an anamorphic lens which has a two-to-one greater magnification vertically than horizontally. In projection, the image is expanded horizontally by means of a lens which is the inverse of the camera lens.

Since the aspect-ratio of television transmission called for in the FCC Rules and Regulations is 1.33, if the full scanning frame is to be utilized for picture information, a significant portion of the film frame will be lost. The degree of cropping is shown in Fig. 2. In the extreme case, for example, participants in a dialogue on the left and right sides of the frame may be lost completely by the confines of the television aperture.

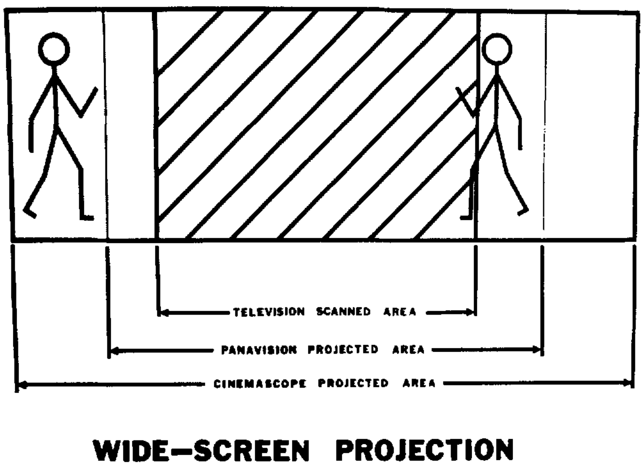

Fig. 2. Scanning the full height of the projected wide-screen image area by the normal television roster results in a substantial loss in picture content.

Thus, in order to reduce either of these wide-screen formats to the narrower television frame-size, without loss of picture information essential to the story, it is necessary to scan the film horizontally with the television aperture. This normally is done by the film processing laboratory in the production of a special print for television transmission. Selection of the horizontal position of the television aperture is determined by a film editor, and this information is entered onto a punched tape which, in turn, is used to control the operation of a step-printer to produce an internegative. In the first system of this type developed by Twentieth Century Fox, the printer operated at a slow speed and was stopped at each cue for repositioning. This obviously results in an expensive, time-consuming operation. Nevertheless, it has served the purpose for many years in providing a means for converting theatrical film to the television format.

An improvement on the early Fox process was introduced in 1969 by Technicolor wherein the television print is produced directly from the original widescreen negative without the need to stop for repositioning. This is accomplished by moving the printer head during pulldown of the film frame. Although the Technicolor system eliminates the need for an internegative and operates continuously, the process is costly in that the film printing and processing operations are not avoided, and time-consuming since the speed of the printer is limited to less than half the real-time speed of 90 feet per minute. Furthermore, the end product in both film systems is a film which, for television use, must either be transmitted by means of an expensive telecine projector and camera system, or transferred to video tape.

In the GCC system, on the other hand, the scanning positioning operation is accomplished during the real-time transfer of the motion-picture film to magnetic tape. The information prepared by a film editor which specifies the horizontal position, and number of feet and frames from the start-of-play, is entered on a keyboard and recorded in digital form on a magnetic tape cassette. A magnetic recording system is used, rather than punched tape such as is employed by film laboratories, in order to simplify correction of any errors in entry or revisions in the editors cueing decisions.

During the transfer operation a rotatable mirror in optical path between the projector and television camera, controlled in accordance with the digital cueing information recorded on the magnetic tape cassette, positions the widescreen image appropriately relative to the narrower aperture of the television camera at the indicated film-frame count.

Consideration was given to positioning the television aperture relative to the projected film frame by varying horizontal centering in the camera. This approach is attractive, since it would eliminate the need for an anamorphic lens with film in the 2.35 aspect-ratio. However, it would result in a substantial loss in horizontal resolution because of the need to reduce horizontal scanning size by a factor of two-to-one. In the case of the 1.85 aspect-ratio, an additional loss in vertical resolution would be encountered. Furthermore, horizontal registration would be difficult to maintain because of variations in tracking of electrical centering among the three color channels. Therefore, electrical positioning was discarded in favor an an opto-mechanical system.

During the scanning operation, the mirror moves to any one of nine equally-spaced positions for Cinemascope prints (five for films in 1.85 aspect-ratio) during the intermittent pull-down of the film frame, at which time the projector light is blanked by a rotating shutter.

The relationship of the blanking of the projector light, the film pull-down, and the mirror movement are shown in Fig.3. The projector shutter provides pulses of light at a rate approximately equal to that of the television field scanning rate of 30 per second. Alternately, successive film frames are projected for six and four television fields; this sequence provides the conversion between the film frame rate of 24 per second and the 30 per second rate of television. Horizontal positioning, when called for by the cueing information, is initiated at the start of pull-down and completed before the end of the shutter blanking.

The shutter blanking duration is 10 ms, whereas the mirror movement is completed in 8 ms. Thus, since the television camera is exposed to only a stationary film-frame image, there is no blurring or smearing of the televised picture as a result of the mirror movement. In other words, the effect in the televised picture is equivalent to an instantaneous change in horizontal positioning of the film frame.

The timing of the projector is sensed by a light-sensitive transistor mounted next to a disc on the drive-shaft for the intermittant geneva movement. Metallic tabs on the disc pass the transistor at the start of pull-down and reflect light to generate a pulse which is used for both frame-count from the start-of-play and for timing the start of the mirror movement.

Fig. 4 is a view of the keyboard and a magnetic tape cassette. A two-position switch selects the mode of operation--write or read. The digital read-out above the keyboard indicates the footage, frame number, and horizontal position number of the cue being entered when in the write mode of operation. During transfer, when the rotatable mirror is controlled by the recorded cues, the read-out indicates the next cue. Another read-out, not shown in the illustration, shows the footage and frame count of the film running in the projector as indicated by the light transistor sensor in the projector.

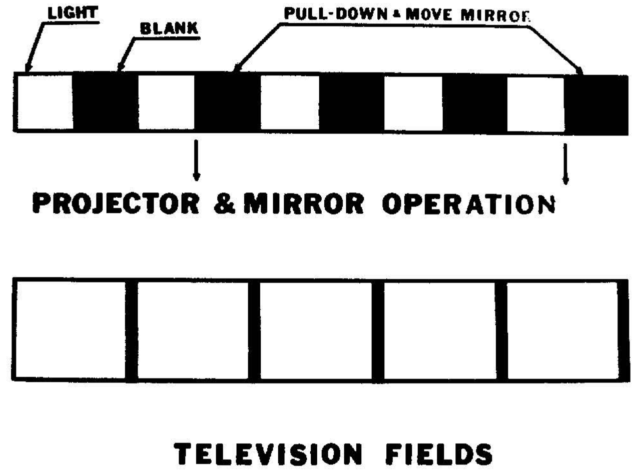

Fig. 3. The projector shutter produces pulses of light at the television field-rate of 1/60-second. Film pull-down is accomplished at an average rate of 1/24-second during shutter blanking. Horizontal repositioning occurs during film pull-down.

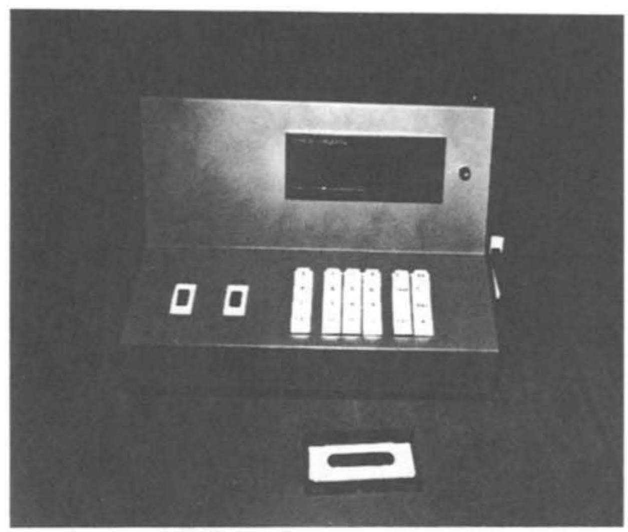

Fig. 4. Scanning cue storage and control system, consisting of magnetic cassette record/playback keyboard for cue entry, frame-count read-out, and next-cue read-out. A cassette is in the foreground.

At the left in Fig. 5 is shown a 35mm projector fitted with an anamorphic lens designed especially for this application by Panavision, Inc. The procurement of a lens for this application posed a unique problem since currently available anamorphic lenses are designed for the long throw and large screen of theater projection, rather than the short throw and small image required for a television camera. The resolution and contrast are equivalent to the non-anamorphic lenses used for films of 1.85 and 1.38 aspect-ratios.

The rotatable mirror and the stepping motor are mounted on a cantalever extension to the television camera mount. The second 35mm projector at the right is used for transfer of films in the 1.38 aspect-ratio. In this application, the mirror is repositioned by 90 degrees. At the right is a rear-projection screen from which the film image is picked up by the television camera.

Behind the lens, and not visible in the illustration, is a light and light-sensitive transistor which is used in automatically indexing the mirror to position zero prior to the start of a recording transfer.

The control system, while complex in solid-state circuitry, is comparatively simple in basic concept. Essentially, it consists of means to store cueing instructions and to compare these with current status information as to frame count and horizontal positioning of the mirror. This is shown by the simplified block diagram in Fig. 6.

Stored in digital form on a magnetic tape cassette are cues specifying the timing at which a horizontal repositioning is to be made and the position number. The timing is in feet plus frames from a start-mark on one frame in the leader. The position number is the horizontal relationship between the film frame and the television camera aperture. For Cinemascope with an aspect-ratio of 2.35, nine equally-spaced positions are used. For the narrower aspect-ratio of 1.85, only five of the nine positions are required to cover the full width of the film frame.

The cueing information is determined by examination of the film in a viewer equipped with a footage and frame counter and a moveable graticule marked with the television aperture for the particular format in use.

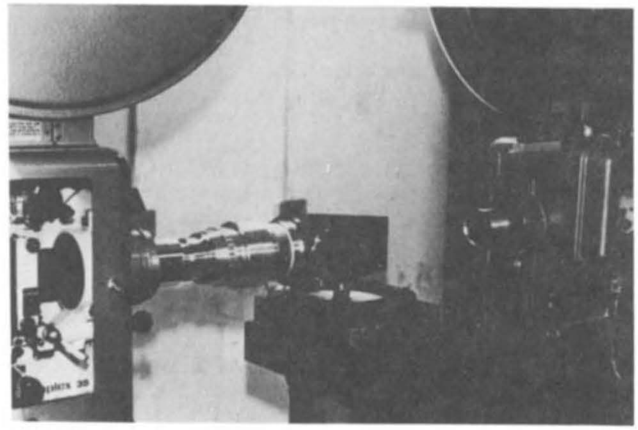

Fig. 5. A rotatable mirror in the optical path between the 35mm anamorphic lens and the television camera, controlled by a stepping motor, provides a variable horizontal positioning of the projected film frame.

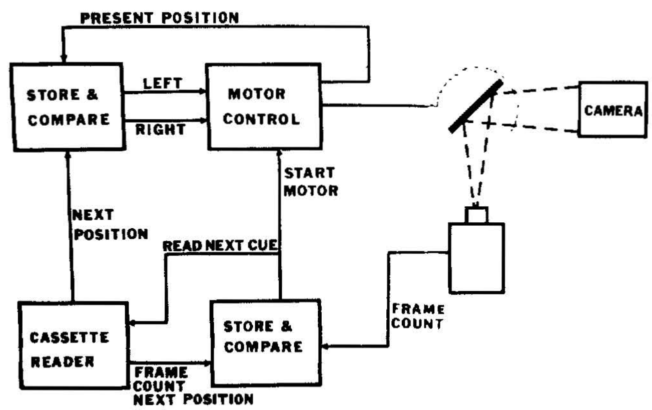

Fig. 6. Block diagram of control system.

In the transfer operation the film is threaded in the projector with the start-marked frame in the gate. Upon start of the projector, the first cue is read out, the footage and frame count converted to total frames and stored in the frame comparator. Concurrently, the position number for the next cue is read out and stored in the position comparator. In addition, the mirror rotates to position zero, as indicated by the light-dependent transistor sensor. The position zero is compared with the position of the next cue and an instruction as to direction and number of steps transmitted to the motor controller.

When the frame count received from the sensor on the projector intermittant equals the stored count, three actions take place:

1) The motor movement is initiated. Since all the frame-count pulses are at the start of shutter blanking, the movement occurs during blanking.

2) The cassette reader is stepped to the next cue and cues are read out to the comparators.

3) The cue read-out changes to indicate the next cueing information.

The system then is ready to repeat to operation at the next coincidence of frame counts.

At present, the system is being used in conjunction with a three-Plumbicon color camera for transfer to the U-Matic 3/4-inch wide cassette tape format or IVC 1-inch format. The camera control, monitoring and operating control and one rack of the bank of recorders are shown in Fig. 7. The operation is conducted in essentially a hands-off manner. In other words, once the start button is pushed, only a surveillance of the operation for occasional adjustment of signal levels and color balance is required.

Fig. 7. Recording control and monitoring in center, camera control at left. At right, two of twelve recorders and quality-control player.

The system has been in operation since February of this year supplying feature and supplementary programming for Warner Cable, Inc.

The video tape product is providing a conversion from the wide-screen film format to the television aspect-ratio with a degree of precision equivalent to that achieved by a film laboratory at a fraction the cost.